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DEPARTMENT OF COMMERCE

BUREAU OF STANDARDS

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Reference book not to be taken from the Library.

GENERAL NOTE

Owing to the current nature of the investigations mentioned in the Technical News Bulletin, sometimes it will be impossible to supply printed information regarding them. However, in these cases, when the investigation has progressed sufficiently far, the Bureau will be pleased to furnish technical data to those engaged in the particular application of the subject, in order to avoid the delay incident to publication.

·l International Commission on Illumination Adopts the Bureau's Visibility Data

At the sixth session of the International Commission on Illumination held in Geneva, Switzerland, July 22,to 25, 1924, a paper was presented giving the results of the investigation on visibility of radiation which have been published in detail in the Bureau's Scientific Paper No. 475. After a discussion of these data the commission adopted the following resolution:

> "The International Commission on Illumination recommends the following values for the factor of visibility, as provisional for general use. In special cases which are concerned with the end regions of the spectrum or with peculiar conditions of field size, intensity, etc., these provisional values may be uncertain; care should then be taken to select and use the special values which correspond to the particular problem."

The values for factor of visibility referred to are those given in table 3 of the Scientific Paper mentioned above. This paper is obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents per copy. An abbreviated account of the investigation, including the table of visibility values, has also been published in the Transactions of the Illuminating Engineering Society, vol. 19, p. 175, February, 1924.

The international adoption of these data on visibility of radiation opens the way for experimental work which will eventually lead to agreement on exact values for standards of candlepower of different types and on the methods of photometry which should be used in comparing the brightness of lights of different color.

2 International Comparisons of Candlepower Standards

While the unit of candlepower originally established by the Bureau was intended to be the same as the British candle, it was derived indirectly, and was later found to be slightly different from the unit in actual use in Great Britain. Through comparisons initiated by the bureau an agreement was reached in 1909 by which the same unit was established in Great Britain, France, and the United States. This unit has since been accepted in several other countries and has been definitely recognized as the "international candle" by the International Commission on Illumination. At the time of its adoption the carbon filament lamp was the only type of lamp and the standards by means of which the unit was established and maintained were of this type.

As tungsten filament lamps came into wider use it became necessary to establish standards of this type, and comparisons were made in 1913 and 1914 with the National Physical Laboratory of Great Britain. The outbreak of the war interfered with the completion of this work, since it made international intercomparisons impracticable. Consequently the bureau established its own standards of the tungsten vacuum type and later of the gas-filled tungsten type with the expectation that slight adjustments in value might be necessary when international comparisons could be made.

During the past summer some lamps of both types have been taken to several European laboratories for preliminary measurements. The results indicate not merely that satisfactory agreement has been maintained in the case of the carbon standards, but also that the tungsten vacuum standards independently established are in unexpectedly close agreement in France, England, and the United States. Foreign laboratories have not found lamps of the gas-filled type suitable for standards of this type. The arrangements have been made for more precise comparisons and detailed results of the measurements will be published later.

3 Electrometer for Measuring High Voltages

The transmission of electric energy over long distances is an outstanding feature of American economic development, especially in the South and along the Pacific Coast. As the distance over which the energy is transmitted increases, higher voltages must be used to avoid prohibitively large investment in copper or aluminum for the line wires. On May 6, 1923, one of the Big Creek power plants in California changed over one of its lines from 150,000 to 220,000 volts, thereby setting a new high record in operating voltages.

While in low-voltage systems the outstanding item of cost is that of the conducting material (usually copper), the chief item in high-voltage systems is the cost of insulating material. Not only that, but the performance of the insulation is of vital importance as regards continuity of service. Methods of measuring high voltages are essential in order that suitable tests may be applied to the insulation of the apparatus.

The facilities at the Bureau of Standards for the accurate measurement of voltage are at present limited to 30,000 volts. To extend this range, a large absolute electrometer is now under construction. This instrument has been designed for an upper limit of 250,000 volts. When it is completed, the bureau expects to be in position to check the accuracy of commercial devices for high-voltage measurements up to the present upper limit in use.

4 Testing of Current Transformers

The number of current transformers tested during the past fiscal year at the Bureau of Standards was over four times the average number submitted during the preceding six years. The reason for this sudden increase originates in a new method for the testing of this class of apparatus in the field. This method was invented at the bureau and has been incorporated in a convenient testing set which has been on the market for somewhat over a year. The public utility companies throughout the country are anxious to maintain their measuring equipment at the highest accuracy, and have adopted this method of testing the current transformers installed on their systems, instead of blindly trusting their accuracy as heretofore. Since the method requires the use of a set of previously standardized current transformers, the bureau has been deluged with requests for this type of standardizing work.

5 Tests of Dry Batteries

The attention of the Bureau of Standards has been called several times to the unauthorized use of its name in connection with the sale of dry batteries for radio receiving sets. No test results of competing brands of batteries have been published. Statements that the bureau has declared any particular brand to be the best or that it has rated certain brands above others are therefore unwarranted.

The tests which have been made at the Bureau of Standards were primarily for the information of Government departments and assistance has been given also to the various manufacutrers who have cooperated in the conferences and tests. Without publishing competitive test data, the bureau's work has been helpful to the public also. In 1919 specifications for dry cells and batteries were published by the Bureau of Standards. These were revised and republished in 1923 as Standard Specification No. 58 of the Federal Specifications Board. The revisions involved raising the requirements for performance, but it is noticeable that a larger percentage of the brands now on the market meet or exceed the specifications than when they were originally formulated. This means that the average quality of the product has been materially improved. At a later date the bureau hopes to issue a more definite statement to show the substantial gain which has been made.

6 Theory of Determination of Ultra-Radio Frequencies by Standing Waves on Wires

The standardization of the frequency of radio waves has assumed a new importance with the increase of public interest in radio and the necessity of avoiding interference between radio stations operating on different frequencies. One of the methods used by the Bureau of Standards in such standardization is the accurate measurement of the length of very short waves on a system of parallel wires. The essential differences between the parallel-wire system employed in this work and somewhat similar systems in the earliest days of radio are: high-frequency voltages are impressed on the wires instead of being caused by discharges originating on the wires, the waves produced are continuous instead of being damped, an electron-tube generating set is substituted for the spark-gap circuit; a current-indicating instrument is used instead of a device for indicating voltage nodes.

Correct results can be obtained if the correction derived in the paper is employed in calculating the frequency. It is shown that the adjustment is based on a condition of resonance and, therefore, the settings are sharp, and it is practical to approach the theoretical accuracy in actual frequency standardization. The paper gives practical deductions that may be drawn from the mathematical theory and also the method of calculating the frequency correction. An appendix gives the complete mathematical theory of the action of standing waves on parallel wires as applied to frequency measurement.

The theoretical background for this method of frequency standardization is furnished by Bureau of Standards Scientific Paper No. 491, "Theory of Determination of Ultra-Radio Frequencies by Standing Waves on Wires," a copy of which may be obtained for 15 cents from the Superintendent of Documents.

7 Piezoelectric Crystals as Radio Standards

Piezoelectricity is an old phenomenon which is having some remarkable new applications. Certain crystals undergo a slight expansion or contraction when an electrical voltage is applied to them, and vice versa produce a slight voltage when compressed or pulled.

Apparatus employing such crystals (quartz and rochelle salt) was developed during the war as a submarine detector, since when placed under water the crystals respond to the sound vibrations produced by the propeller of a submarine. Any piece of quartz crystal has certain natural frequencies of vibration, like a tuning fork, except that the frequency is very high. A piece of quartz crystal 1 or 2 inches long has a natural frequency of the same order as the frequencies of currents used in radio communication. American investigators have found that the frequency of vibration of the piece of quartz is extraordinarily constant, and that it is a very useful radio standard.

The quartz crystal may be used as a standard in numerous ways. In one method, it forms an auxiliary condenser in a resonance circuit, and when the current in the circuit is made to have a frequency equal to that of natural vibration of the crystal there is a definite power absorption from the circuit. In another method the quartz crystal, in association with a small electron tube, acts as an oscillator or generator of a current the frequency of which is that of mechanical vibration of the piece of crystal. As the frequency thus produced is accompanied by numerous harmonics, th crystal is a standard giving several radio frequencies. It is thus a supplement to the wave meters which have hitherto been used as standards of radio frequency and it appears to be of greater constancy than the best wave meters.

Studies being made by the bureau indicate that such a quartz oscillator has many valuable applications in radio work. Means of producing audio as well as radio frequencies are being worked out. The crystals can be used to control or determine the frequency of a transmitting station and to hold it strictly constant. This will mean a great advance in radio transmission technique. The crystals are also useful in accurate setting of receiving apparatus and in controlling the frequency of radio-frequency generators used in laboratory measurement work. The value of these various applications will be particularly great at the frequencies above 2,000 kilocycles which are now rapidly coming into use.

No publications on this work have as yet been prepared by the bureau but when such publications become available they will be announced in the Bulletin.

8 Extension of Standard Radio Frequency Transmissions

For the past two years the Bureau of Standards has been transmitting approximately twice a month, radio signals of standard frequency, which have been utilized throughout the eastern half of the counrty. In order to extend the territory covered, transmitting equipment and standards have been installed at Stanford University, California, with the cooperation of that institution. The station thus established inaugurated on September 5 the transmission of similar signals of standard frequency, thus duplicating in the West the service rendered by the Bureau of Standards in the East.

The frequencies included in the past transmissions have been from 125 to 2,000 kilocycles (2,400 to 150 meters). In order to make the transmissions of still greater service, they will be extended to include frequencies up to 6,000 kilocycles. The future transmitting schedules which have been definitely arranged are given below.

These special signals of standard frequency are of use to testing laboratories, transmitting station operators, and others in standardizing wave meters and adjusting transmitting and receiving apparatus. The accuracy of the frequencies is better than three-tenths of 1 per cent. Information on how to receive and utilize them is given in Bureau of Standards Letter Circular No. 92, which may be obtained on application from the Bureau of Standards, Washington, D. C.

All transmissions are by unmodulated continuous-wave telegraphy. A complete frequency transmission includes a "general call," a "standard frequency signal," and "announcements." The "general call" is given at the beginning of the eight-minute period and continues for about two minutes. This includes a statement of the frequency. The "standard frequency signal" is a series of very long dashes with the call letters (WWV or 6XBM) intervening. This signal continues for about four minutes. The "announcements" are on the same frequency as the "standards frequency signal" just transmitted and contain a statement of the measured frequency. An announcement of the next frequency to be transmitted is then given. There is then a four-minute interval while the transmitting set is adjusted for the next frequency.

The schedule of standard frequency signals from both the Bureau of Standards and Stanford University is as follows. Attention is called to the change in time, previously announced schedules having begun al 11 instead of 10 p.m.

(See Table on page 260)

9 Radio Standardization

During the past year interest has increased and an organized effort in the standardization of radio apparatus, has begun. Progress in this direction continues. The Bureau of Standards participates in this work through representation on the various committees and boards which are engaged in the several phases of the movement.

A sectional committee on standardization of apparatus and nomenclature has been organized under the procedure of the American Engineering Standards Committee. It has 26 members, representing various producing, consuming, distributing, and general radio interests. Its technical work will be carried on by subcommittees on the following subjects: transmitting and receiving sets and installations, component parts and wiring, electron tubes, electroaccoustic devices, power supply and outside plant.

The Interdepartment Radio Advisory Committee gives attention to standardization of radio equipment for Government use through the work of its subcommittee on technical problems.

Schedule of Frequencies in Kilocycles

(Approximate wave lengths in meters in parentheses).

Time[2]	1924 October 8	October 21	November 5[2]	November 20	December 5
10.00 - 10.08	1,350 (222)	1,900 (158)	3,000 (100)	125 (2400)	300 (1000)
10.12 - 10.20	1,420 (211)	2,000 (150)	3,400 (88)	133 (2254)	315 (952)
12.24 - 10.32	1,500 (200)	2,200 (136)	3,800 (79)	143 (2097)	345 (869)
10.36 - 10.44	1,600 (187)	2,400 (125)	4,200 (71)	155 (1954)	375 (800)
10.48 - 10.56	1,700 (176)	2,600 (115)	4,600 (65)	166.5 (1800)	425 (705)
11.00 - 11.08	1,800 (167)	2,800 (107)	5,000 (60)	205 (1463)	500 (600)
11.12 - 11.20	1,900 (158)	3,000 (100)	5,500 (55)	260 (1153)	600 (500)
11.24 - 11.32	2,000 (150)	3,200 (93.7)	6,000 (50)	315 (952)	666 (450)

[1]Eastern standard time for WWV, Washington, D. C. Pacific standard time for 6XBM, Stanford University, Calif.

[2]The schedule for November 5 is tentative for station 6XBM, Stanford University; later announcement will be made if there is any change.

It has recently adopted a standard receiving electron tube which is recommended for use by the Government departments. Before a company can submit bids for these tubes it must submit a sample of 50 tubes on which specified tests must be made. The Bureau of Standards; Signal Corps; and Bureau of Engineering, Navy Department, cooperate in making these tests. One company has already submitted samples. The committee is now working on standard 50-watt transmitting tubes and condensers for radio use.

A Committee on Radio Apparatus has been formed by the Federal Specifications Board. This committee will adopt standard specifications for use in purchase of radio equipment by all Government departments.

The standardization committee of the Institute of Radio Engineers is preparing a revision of the "Definitions of Terms and Standard Graphical Symbols" (1922). This work is proceeding actively through subcommittees which handle the following branches of the subject: Radio telegraphy transmitting sets,

radio telegraphy receiving sets, radio telephony, electron tubes, antennas, direction finding apparatus and systems.

10 Radio in Hospitals

One of the most useful fields for radio is the reception of broadcasting in hospitals. Besides the benefit to patients through the entertainment provided, medical authorities testify to the actual therapeutic value of the mental relief thus afforded. The Bureau of Standards is assisting in the technical phases of current movements to equip many thousands of hospital beds with radio service. Since the middle of March of this year S. L. Rothafel, managing director of the Capitol Theatre, New York, N. Y., and his broadcasting artists have been raising funds for the installation of radio in the United States military service hospitals. A technical committee of Government experts (representing the Signal Corps, Navy Department, and Bureau of Standards) is furnishing technical advice as to the material and method of installation for these hospitals. The first hospitals equipped were Walter Reed General Army Hospital, Naval Hospital, and Mount Alto Veterans Bureau Hospital, all located in Washington, D. C.

The general system employed is to use one receiving set and a powerful amplifier to supply the entire hospital, each patient being provided with head telephone receivers which can be connected or disconnected at will. The amplifier used is capable of supplying about 3,000 headsets in parallel, and by reducing the number of headsets and using suitable transformers a number of loud speakers may also be used in the various rooms. At Walter Reed Hospital 1,500 headsets and six loud speakers are used, the loud speakers being provided for assembly halls only. This equipment requires the services of one man continuously while the set is in operation to control the volume of sound delivered to the patients. The set used is capable of receiving distant as well as local programs, but because of disturbances that may be introduced in distant reception, local programs are used except on special occasions where a program of very general interest is being broadcast from a distant station. The installation includes a microphone which is used for the distribution to the patients of programs given in the auditorium or elsewhere in the hospital. This microphone makes it possible for any person to address all the patients of the hospital simultaneously. The installation has been in operation for four months and has been very satisfactory.

The work of equipping other hospitals is being continued and the material for all service hospitals in the vicinity of New York, N. Y., has been ordered. The aim of the movement is to make it possible for every patient in all the military hospitals of the United States to listen to radio programs. A large part of the money for this purpose has been raised and the campaigns are being continued. Similar campaigns for the equipping of nonmilitary hospitals in various places have been begun

11 Effect of Fatigue on Magnetic Properties

The statement has often been made that the progress of a fatigue failure in steel caused by repeated stresses is accompanied by a corresponding change in magnetic properties. In view of the fact that there is no record of any experimental verification of this statement, the bureau is undertaking to study the effect of fatigue on the magnetic properties of steel. Preliminary experiments have been made using a rotating beam machine of the Farmer type, but as this machine appears to be unsuitable for the purpose a Haigh alternating stress machine has been obtained for this work. This machine is electromagnetically operated and applies repeated cycles of axial stress to the specimen under test at the rate of about 2,000 per minute. This investigation is part of a more comprehensive program for the investigation of the possibilities of magnetic analysis for the nondestructive testing of wire hoisting rope.

12 Measurement of Cyclic Changes of Resistance

Methods have been developed by the bureau for the measurement of small cyclic changes in electrical resistance when such changes can be definitely synchronized with an alternating current. These depend for their action upon the rectification produced when an alternating current is passed through a conductor in phase with a change in its resistance, and are extremely sensitive and selective.

The sensitivity is such that under favorable conditions it is possible to detect a cyclic change in resistance when this change is no larger than a hundred millionth part of the resistance of the conductor in which it occurs, and the selectivity is such that a change in resistance of the same frequency as that of the test current can be measured while there are other changes which may be a thousand or even a million times larger. Further, the apparatus required for the use of these methods is fairly simple. It seems, therefore, that they may have annumber of scientific and technical applications.

13 Measurements of the Electrical Properties of Insulating Materials Under High Hydrostatic Pressure

In connection with the investigation of insulating materials for use with submarine cables, the bureau has found it necessary to prepare apparatus for measuring the insulation resistance, capacitance, and power factor under high hydrostatic pressure. This has been accomplished by covering a wire with the material to be investigated, putting the wire in a strong pipe which can be filled with water under high pressure, and attaching one end of the wire to an insulated connection which is brought out through a plug in one end of the pipe. By using double, extra strong pipe having three quarter inch internal diameter, it has been possible to maintain pressures up to 10,000 pounds, per square inch. The pressure is produced by a small hand pump. The pipes are 20 feet long, permitting the use of a specimen of this length. With such specimens, the

resistance is sufficiently low and the capacitance sufficiently high to permit of satisfactory measurements.

One of the greatest difficulties has been in devising a method for making electrical connection with the wire of the specimen. This finally has been accomplished in the following manner. The end of the pipe is threaded so that it can be closed with a coupling and plug. Through the plug there is machined a conical hole with the large end on the inside. This hole is fitted with a hard rubber bushing through which extends a conical metal core. To prepare a specimen for putting under pressure, one end is sealed and the wire at the other end is attached to the inside end of the conical core in the plug. The plug is screwed into the coupling which is then partly filled with a plastic insulating material. The specimen is then put into the pipe and the coupling screwed into place.

Up to the present time results have been obtained on only a few specimens. The capacitance of a sample of gutta percha does not change to any great extent when subjected to pressure, even when the pressure is maintained for considerable time. When rubber is subjected to hydrostatic pressure, the capacitance is not at first greatly changed, but when kept under pressure it slowly increases with time. This indicates that the change is due to water absorption in the rubber. This water absorption, however, does not appear to change the power factor or insulation resistance to any great extent.

14 Examination of Corroded Ocean Cable

The broken end of a telegraph cable connecting Seattle, Wash., and Alaska was examined to determine whether the failure of the steel supporting wires was due to corrosion in salt water or to erosion against the sea bottom. About 4 feet away from the broken end there was a kink in the cable. At the kink the sharply bent wires had become very thin. It is well known that corrosion proceeds much more rapidly in strained than in unstrained metal. It appears, therefore, that the thinning down of the wires at the kink was caused by the accelerated corrosion of the bent wires, and that probably a kink had also existed at the point where the cable broke. The appearance of the surfaces of the wires at the fractured end as shown under the microscope, indicated that corrosion had taken place. Apparently the failure resulted from allowing a kink to form during the laying of the cable and not by the erosion of the cable against some object on the sea-bottom.

15 Electrical Properties of Rubber

In making measurements of the dielectric constant and power factor of rubber samples the bureau has observed that when water electrodes were used there was a change in the electrical properties with time. To determine the amount of change samples were carefully dried in a dessicator for several days. They were then placed in a holder arranged to use

water electrodes. Measurements were made at frequent intervals over a period of several hours, the rubber being kept in contact with the water during this time. In all cases the capacitance increased with time, quite rapidly at first and more slowly later. The increase in some cases was as much as 10 per cent. There was no appreciable change in the thickness when measurements were made before and after putting in the holder. Hence it is assumed that the dielectric constant increased to the same extent as did the measured capacitance. There is an indication that this can be accounted for by the high dielectric constant of the absorbed water. The power factor showed a rather rapid increase for five or six hours, at which time it was double that of the specimen at the beginning. At this time, however, the power factor reached a maximum and thereafter decreased slowly with time, so that at the end of 24 hours the power factor was practically the same as at the beginning. No explanation of this peculiar phenomenon has been found.

16 Instrument for Measuring the Consistency of Rubber Stocks

The Bureau of Standards has constructed a plastometer for studying the relative consitency of rubber stocks. The instrument is similar to the Marzetti plastometer except that the rubber is forced out under constant air pressure through a short capillary instead of through an orifice. The rate of extrusion of the rubber is taken as a measure of the consistency. While this instrument is not adapted to the absolute measurement of plasticity, it is very convenient and useful for studying the rate of "setting up" of rubber stocks containing accelerators, and gives definite information as to the time and temperature at which such stocks may be processed.

17 The Comparative Durability of Vegetable-Tanned and Chrome-Tanned Sole Leather

The final results of four series of wear tests for comparing the durability of chrome and vegetable-tanned sole leathers have been compiled, as follows:

Series	Days wear per iron		Percent greater wear of the chrome leather
	Chrome	Vegetable	
1	10.1	8.2	23.2
2	23.9	11.3	111.5
3	16.0	11.4	40.3
5	20.9	9.7	115.5

The chrome leather in series 1 and 3 was filled with grease and mineral salt, in series 2 the natural chrome was used, and in series 5 the chrome leather was filled with paraffin.

18 Specifications for Built-Up Bituminous Roofing

United States Government master specifications for the construction of built-up bituminous roofing of various types are contained in Circulars Nos. 176 to 181 inclusive of the Bureau of Standards, which have just been issued. These circulars cover Federal Specifications Board specifications 152 to 157, inclusive. The price of each from the Superintendent of Documents is 5 cents per copy.

These specifications were prepared by the technical committee on bituminous water-proofing and roofing materials of the Federal Specifications Board. In their preparation careful consideration was given to suggestions received from the manufacturers of the materials used, roofing contractors, large consumers of roofing, and other interested parties.

19 Water Resistance of Waterproofed Paper Board

In cooperation with a manufacturer of asphaltum water proofed paper board, the bureau is carrying out some comparative tests of the water resistance of such papers. The manufacturer is using as a control test of water resistance a new method known as the "Dessicator Method", which was described in the Paper Trade Journal, June 26, 1924. In this method the weight of water vapor passing through a sample placed between a dry and wet atmosphere is measured. Tests made in this manner by the manufacturer are being compared with ones carried out by the bureau, using the "Ground Glass Method" devised in the paper section, and which was mentioned in T.N.B. No. 87, Item 19.

20 Utilization of Grasses, Straws, and Similar Materials for Paper Making

The investigation of the possibilities of carua fiber as a paper-making material has been continued during the past month with very satisfactory results. The data obtained thus far show that either an exceptionally strong wrapping paper or a very fine writing paper can be obtained from this fiber.

The work, which was carried out on three samples of carua fiber, each of which had received a different treatment, gives data which show a yield of from 40 to 67 per cent, depending on the sample and the amount of chemicals added. A 60 per cent yield of pulp was obtained from sample No. 2, when 20 per cent caustic was used, figured on the fiber. This pulp bleached easily at or below 13 per cent, giving a very good, white-colored stock, which would compare favorably with rag stock.

This investigation will be continued.

21 Use of Glue in the Manufacture of Paper

The work which is being conducted at the bureau on the use of glue for coating paper has been mentioned in several recent numbers of the Bulletin.

In connection with this work a manufacturer recently made five runs of coated paper using glue under the ordinary commercial mill conditions. Three grades of glue were used; a high-grade hide glue, a low-grade bone glue, and a medium-grade bone glue blended with hide glue.

No difficulties were experienced by the operators in coating with the glue-clay mixtures. Even in the adjustment of the machines for giving the proper weight of coating no trouble was encountered. From observation of these five runs, it is apparent that the technique of coating with glue is practically the same as when using casein as a binder, and a change from casein to glue would involve no change in mill equipment. The preparation of glue for coating is simpler than the preparation of casein, requiring no stirring and no addition of solvents. However, glue mixtures must be kept warm during the coating operation, while casein is used at room temperature, but it is a simple matter to provide for this necessary heating of the glue.

Additional experiments have been made in the bureau's mill on the elimination of blotchiness in the coating. This defect was found in coatings made both with casein and with glue, and apparently it is due to insufficient deflocculation of the clay. Evidently great care in the manner of mixing and screening the coating preparation is required to overcome this trouble.

A report on this subject is being prepared for publication.

22 Measuring the Color of Paper.

The bureau is cooperating with a manufacturer of white bristols, who is endeavoring to improve the color of these papers. This work may give some interesting results in connection with the use of the Pfund colorimeter for measuring this property. Various dyes are being used in the mill and the tinting effect produced will be measured with the above instrument.

23 Development of a Standard Strength Test for Papermaking Fibers.

In connection with the development of a standard strength test for papermaking fibers, the bureau has made a rather extensive study of the uniformity of sheets of pulp made by means of a suction mold. The results obtained show that very uniform sheets can be obtained with this apparatus and that it appears to be well adapted to the purpose.

A report giving a description of the construction and manner of operation of the mold, together with some of the results obtained, is being prepared for publication.

24 Effect of Paper on the Tarnishing of Silver.

The bureau's investigations on the tarnishing of silver have recently been published in Metal Industry. One phase of this investigation, which was not mentioned in this paper, is concerned with the effects produced by the so-called anti-tarnish papers that are used for the wrapping of silverware. Several sections of the Bureau cooperated in conducting these tests on a considerable number of samples which were furnished by various manufacturers. Specimens of silver wrapped with strips of the papers under test were placed in air tight desiccators which were then evacuated and refilled with purified air. One set of specimens was kept in a dry atmosphere and a

similar set in a moist atmosphere for a period of about one year. At the conclusion of this time the specimens were examined and it was found that the tarnishing effect of the papers although slight was sufficient in some cases to be objectionable. The tarnishing effect was more pronounced on those specimens which were kept in the moist atmosphere, which confirms previous conclusions as to the effect of moisture in the tarnishing of silver. Some of the results are not clearly understood and it is proposed to extend the investigation.

25 Testing the Covering of a Nickel Deposit.

In the study of nickel electrotyping a simple method of testing the covering power of the nickel deposit on a wax surface coated with graphite has been developed. With this apparatus it is planned to make a survey of the different variables in nickel electrotyping, in order to determine which are most significant and will therefore require the most intensive study.

26 Nickel Plating on Iron and Steel.

The study of the protective value of nickel plating on iron and steel is being continued. The indications are that it is very difficult to secure impervious deposits of nickel on iron and steel. It appears probable that some at least of the results of others in which high resistance in the salt-spray test was obtained, are accounted for by the presence of buffing grease in the pores of the nickel deposit.

27 Chromium Plating.

A brief investigation of the possibilities of chromium plating is being made in order to determine, if possible, what conditions will lead to the production of uniformly satisfactory deposits. The bureau is chiefly interested at present in the hardness of the deposited chromium and its possible application upon gauges and upon printing surfaces. From present indications the process is not yet well defined and consequently the results are somewhat erratic.

28 Bureau Circular on Nickel

The second edition of Circular 100 of the Bureau of Standards has recently been issued, and may be obtained from the Superintendent of Documents at 20 cents a copy. This paper deals with the forms, uses, and alloys of nickel.

The larger part of the worlds production of nickel comes from the famous pyrrhotite-chalcopyrite ores of the Sudbury district in Canada. These ores are at present smelted and refined by three processes, the larger tonnage being smelted in Canada and refined both there and in the United States by the Orford process. A natural alloy, Monel metal, is produced from the same ores by roasting and reducing the copper-nickel matte shipped to New Jersey from the Canadian smelters.

Nickel is produced in the United States in several commercial forms, including 50 or 25 pound ingots or pigs used in the manufacture of nickel-bearing alloy steels; nickel shot, and electrolytic nickel cathodes which are employed by

the manufacturers of nonferrous nickel alloys; nickel-silver; and cupro-nickel. Malleable nickel, in the form of sheets, strips, rods, and wire, is produced for stampings, fittings, resistance and pyro meter wire, spark plug points, and kitchen utensils. Nickel castings are used by the chemical industries because of their resistance to corrosive solutions, in fact the employment of this metal in many lines of work is often due to its anti-corrosive properties.

Monel metal, which is made up in the usual forms of castings, rods, sheets, and wire, is principally valuable because of its high strength at elevated temperatures, and its resistance to corrosion and to the erosive action of superheated steam. This makes it particularly adapted for use in steam turbines and valves.

Besides the nickel, or nickel-chromium alloy steels containing from 1 to 3.5 per cent nickel, and largely used for automobile and ordnance construction, there are many other nickel-bearing alloys which possess very interesting and commercially useful properties. Among these alloys are:

Nickel-silver, containing from 52 to 80 per cent of copper, 10 to 35 per cent of zinc, and 5 to 30 per cent of nickel, is used in sheet form as the base metal for silver-plated household ware and other stampings and fittings, in the wire form for resistance wire, and in the cast form for automobile hub caps, etc.

Cupro-nickel, containing about 15 per cent of nickel and the balance copper, is used for the manufacture of small arms bullet jackets.

Constantan, which contains about 45 per cent nickel and 55 per cent copper, is used largely for resistance and pyrometer wire.

Ferro-nickel, or 25 to 35 per cent nickel-steel, is employed as resistance wire and under the name of "Invar" is used for many purposes where a low coefficient of thermal expansion is desired.

Nichrome and similar alloys, containing from 60 to 80 per cent of nickel, together with chromium and iron, are used for resistance wire, and as a heat resisting alloy.

Manganese-nickel alloys, containing from 2 to 4 per cent of manganese and the balance nickel, are used largely for the manufacture of gasoline engine ignition points, and spark plug electrodes.

29 Theory of Bimetallic Bars.

Bimetallic bars are employed in thermostatic controls and for temperature compensation in instruments. Although such bars are widely used, no satisfactory theory of their performance has yet been developed. Since the bureau receives numerous inquiries along this line, an investigation of the subject has been started.

This work so far has covered the development of a performance theory in its most general form so as to include the curvature of the bars both longitudinally and laterally. The theory as developed has been tested experimentally for several invar-brass bars. The correspondence of the experimental and theoretical deflections is excellent, the two agreeing within less than 10 per cent.

30 Moisture Content and Temperature of Molding Sands.

In connection with the bureau's investigation of the properties of molding sand, the moisture of sands used in the bureau's foundry, as well as temperatures of molten metals during pouring, were recorded daily during the past month, temperature being measured by means of an optical pyrometer. The moistures determined varied from 6.89 to 7.96 per cent for Albany 00 sand, and from 8.38 to 9.94 per cent for Lumberton sand, while temperatures observed were within 1,018 and 1,170°C. for bronzes and within 1,226 and 1,388°C. for cast iron.

31 Soil-Corrosion Investigation.

In the soil-corrosion investigation which the bureau is conducting, the examination of the first series of specimens has been completed. This series comprises one set of specimens from each of 46 locations distrubuted throughout the country. Each set comprises the following materials; Bessemer steel, open hearth steel, copperoid steel, spellerized steel, wrought iron, ingot iron, sand cast iron, duriron, lead pipe, lead cable sheath, and fiber pipe. About half of the sets contain also specimens of De Lavoud centrifugal cast iron. The specimens have been in the ground for periods varying from one to two years. These specimens have now been cleaned, weighed, and inspected, and a progress report is in preparation. A conference of representatives of pipe manufacturers for study and discussion of the results took place on September 30, and it is expected that the first progress report will be issued soon.

32 Effect of Moisture on Sulphur-Impregnated Sandstone.

In T.N.B. No. 84, item 12, a brief description was given of some experiments which the bureau had been conducting on sulphur-impregnated sand-stone.

The tests showed that the strength of the stone can be greatly increased by a few hours immersion in molten sulphur, and that porous materials are rendered practically watertight. This indicated the possibility of a commercial application of the process, and considerable interest was manifested from various sources.

A further study of the effect of the treatment has brought to light the fact that some sandstones can not safely be treated in this way, since they decay rapidly under moisture conditions. Until more is known concerning the chemical action which appears to take place between the sulphur and certain constituents of the stone, the bureau believes that the process should not be tried for commercial purposes.

33 Cooperative Investigation of Impact Stresses in Bridges.

During the last three years a cooperative investigation of impact stresses in highway bridges has been in progress, the cooperating bodies being the American Society of Civil Engineers, Iowa State College Engineering Experiment Station, Iowa State Highway Commission, and the Bureau of Public Roads, Washington, D. C. Last year the Bureau of Standards was invited to take part in this work with a view to making use of its recently developed electric telemeter for strain measurements, a description of which will be found in Technologic Paper No. 247. To this end the bureau superintended the design and construction of a 12-element telemeter outfit of the oscillograph type, which could be used as a recorder or as a direct reading instrument, as desired. With this instrument true records may be made of impact stresses from motor trucks passing over obstructions on bridge floors and other similarly applied loads. The records from each of the 12 instruments, which may be placed at widely separated points about the structure, are made simultaneously upon a single strip of photographic paper 12 inches wide.

A member of the bureau staff was made available for the summer to operate the instruments, and although it has not been possible to carry out a large quantity of work on account of unavoidable delays, the instrument itself has functioned in a satisfactory manner under field conditions. The field work is being carried on under the direction of the civil engineering staff of the Iowa Engineering Experiment Station at Ames, Iowa.

34 Tests of Some Girder Hooks.

Mild-steel hooks having rectangular cross sections are often used for lifting steel girders. Two hooks with their curved ends together are placed on a link carried by the crane hook.

Hooks of this kind are usually designed by combining the tensile and bending stresses. To determine the safety of hooks designed in this way, nine were tested recently by the Bureau of Standards, three each for the following loads: 5, 10, and 15 tons. The hooks were supplied by the engineering department of the American Bridge Co.

The hooks were loaded, using several increments, up to the proportional limit of the material, which was obtained by testing coupons cut from each hook. The stresses on the inside and outside surfaces of the hooks were measured experimentally with strain gauges, having 2-inch gauge lengths. Readings were taken along practically the entire length of each hook.

The stresses for the same gauge lines were also found, theoretically, by adding, algebraically, the stress due to the component of the load normal to a right section of the hook, and the stress due to bending at that section. The

bending stress was computed by using the ordinary beam formula. The experimental and theoretical stresses were plotted for comparison in load-stress diagrams for each hook.

The maximum stresses in the hooks were also computed from the Winkler-Bach and the Andrews-Pearson formulas derived from the theory of curved beams.

As the result of this work the following conclusions have been drawn:

(1) The stresses obtained from strain-gauge measurements on girder hooks of rectangular section agree well with the stresses computed by the ordinary theory of combined tension and bending, except at the critical section.

(2) The experimental stresses at the critical section are higher than the values computed by the ordinary theory of combined tension and bending for all but one of the hooks. The results indicate that the Winkler-Bach and the Andrews-Pearson formulas, which take into account the curvature of the hook, give correct values for the stress.

(3) The stress computed by the Winkler-Bach and the Andrews-Pearson formulas was in no case more than 20 per cent greater than the stress computed by the ordinary theory of combined tension and bending. Therefore, if the factor of safety used in designing hooks of this kind is sufficiently large, it is believed that the use of the more exact formulas is not necessary.

(4) It is impossible to determine by visual inspection whether any part of the hook has been stressed beyond the proportional limit.

For more detailed information covering this investigation Technologic Paper, No. 260 should be consulted. Copies may be obtained at 10 cents apiece from the Superintendent of Documents.

35 The Strength of Airplane Struts.

An investigation carried out by the bureau indicates that values for the strength of airplane struts which may be dangerously above the actual strength are apt to be given by the formulas now in use for calculating the strength of these members. A modified formula has been devised which is in closer accord with actual strut conditions as determined by experiment, and the values given by it are found to be in close agreement with those given by tests.

In this connection, the bureau conducted a series of tests on struts of steel tubing carrying end loads as columns and bending loads at the same time, a condition which is frequently encountered in airplane design. The proportions of the loads ranged all the way from a column without bending load to a beam without end load, and the strength as measured in the tests was compared with that given by the formulas.

Failure to take account of possible eccentricity of the load was largely responsible for the trouble with the formulas. A method was devised for measuring this factor, and the modified formula takes it into account. Such eccentricity may be caused by uneven wall thickness or by lack of straightness of the strut. It results in putting an undue proportion of the load on one side of the tube, and is found to be a very important factor in determining the strength of a strut.

The results of these tests, together with a consideration of various formulas for use in designing columns and struts, are given in Technologic Paper No. 258, copies of which may be obtained from the Superintendent of Documents, at 15 cents apiece.

36 Gasoline-Air Ratios for Internal Combustion Engines.

Results of tests made in the Altitude Laboratory of the Bureau of Standards have been analyzed to ascertain the gasoline-air ratio which will enable an aviation engine to develop its maximum power. A detailed report of this analysis has been published by the National Advisory Committee for Aeronautics. For the engines tested the ratios ranged between 0.07 and 0.08 pound of gasoline per pound of air. Were it possible to obtain perfect mixing of the gasoline and air and perfect distribution of the mixture to the individual cylinders of the engine, undoubtedly maximum power could be obtained with somewhat leaner mixtures. The values as given, however, are based on actual tests and include whatever excess fuel was necessary to compensate for imperfect distribution and imperfect mixing.

Fuel-air ratios leaner than those giving maximum power give better economy; that is to say, lower values of pounds of fuel per horsepower hour. With the distribution as good as is ordinarily found in a multi-cylinder aviation engine, the mixture can be leaned until the power has been decreased 10 or 15 per cent before any cylinder receives a mixture too lean to fire. While in these tests the lowest specific fuel consumption very often was obtained with the leanest mixture with which the engine could operate satisfactorily, its actual value was but little lower than that obtained when the mixture had been leaned only to such an extent as to cause a 5 per cent decrease in power. The advantage of operating with a mixture which has been leaned only to such an extent as to cause a 5 per cent decrease in power lies in the fact that this mixture ordinarily is far from being so lean as to cause any cylinder to fail to fire or to cause firing in intake manifold or carburetor.

37 Organization of the American Marine Standards Committee, and its Constitution and Rules.

A paper has recently been issued by the simplified practice division of the Bureau of Standards, which describes the plan of organization devised for carrying out simplified practice in the marine field. The scheme is applicable in principle to other industrial and commercial fields, wherein, with a minimum of administrative supervision, a large aggregate volume of volunteer technical service is rendered for the com-

mon benefit by distributing among the units of the field separate subjects for study and development of standards, without imposing burdensome work upon individuals.

An organization chart is included.

Copies of this publication may be obtained from the Superintendent of Documents at 5 cents apiece.

38 Logging and Sawmill Safety Code.

The American Logging and Sawmill Safety Code prepared by a representative sectional committee under the rules of procedure of the American Engineering Standards Committee under the sponsorship of the Bureau of Standards, is now available from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 60 cents per copy. This code covers the hazards incident to the felling of timber, the conveying of sawed logs from the stream to the railroads or rivers, transportation by logging railroad including safety specifications for such roads, river driving, snow and ice roading, rafting and fluming. There is also a section on the use, storage, and transportation of explosives and inflammable liquids, as a large proportion of the accidents in the lumber industry is due to these causes.

Part 2 of the code covers sawmill operations, including mill design and lay out equipment for handling saw logs, protection of sawing machinery, together with edgers, gang saws, resaws, trimmers and slashers. Additional sections cover conveyors used for handling material and also miscellaneous machinery, such as lath and shingle equipment. Part 3 covers yard operations, including dry kilns, lumber stackers, and railroad tracks located between mill yards as well as machinery for handling lumber.

This code was prepared by representatives of State administrative bodies, lumber manufacturers organizations, technical and safety organizations, manufacturers of sawmill and logging equipment, insurance representatives, and representatives of labor, and has been approved as a tentative standard by the American Engineering Standards Committee. It is designed as a guide for State codes and for voluntary adoption by lumber manufacturers. That the Logging Code is needed is indicated by statistics prepared by the Prudential Insurance Co., which give 837 as the total number of fatalities in this industry for the year 1916. Owing to the larger number of mills and greater amount of lumber cut at the present time this number is probably more nearly 1,000 per year.

PUBLICATIONS OF THE BUREAU OF STANDARDS RELEASED DURING SEPTEMBER

Technologic Papers

T259 Saturation relations in mixtures of sucrose, dextrose and levulose. Richard F. Jackson and Clara Gillis Silsbee, 10¢

T260 Tests of some girder hooks. H. L. Whittemore and Ambrose H. Stang, 10¢

Circulars

C168 United States Government Master Specification for asphalt for unsurfaced built-up roofing, 5¢

C182 United States Government Master Specification for record and copying ink, 5¢

C183 United States Government Master Specification for writing ink. 5¢

C184 United States Government Master Specification for red ink. 5¢

C185 United States Government Master Specification for stamp-pad ink. 5¢

C186 United States Government Master Specification for typewriter ribbons. 5¢

C187 United States Government Master Specification for hectograph ribbons. 5¢

C188 United States Government Master Specification for ribbons for computing and recording ribbons. 5¢

C189 Recommended Specification for quicklime and hydrated lime for use in the absorption of carbon dioxide. 5¢

Simplified Practice Recommendations

R11 Elimination of waste, Bed Blankets. 5¢

These publications can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices indicated above.

Respectfully,

George K. Burgess, Director.
HGB.